The Sentinel 5 precursor cloud support product (FRESCO)

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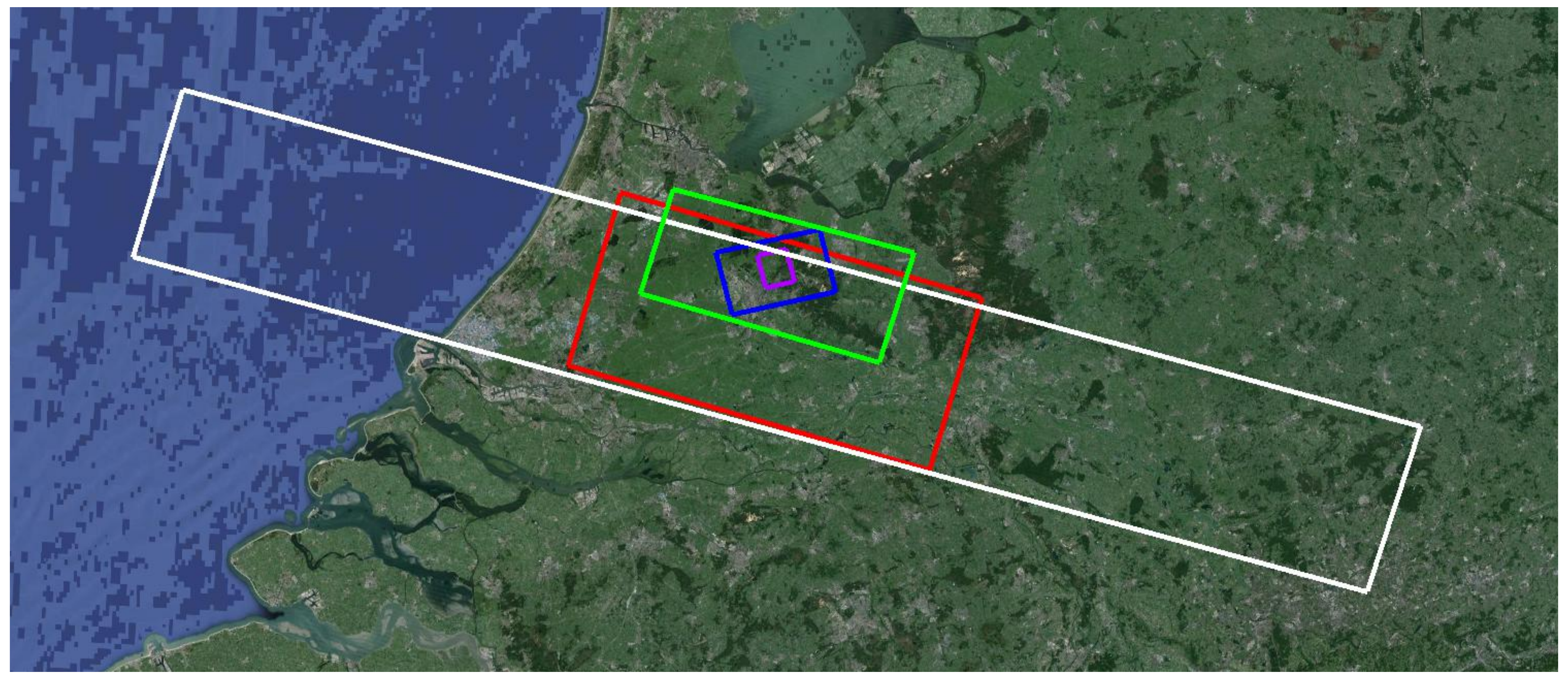
TROPOMI on the Sentinel 5 precursor mission is a next generation OMI. It covers the OMI wavelength range, plus two bands in the near infra-red (675-775 nm) and shortwave infra-red (2305-2385 nm), continuing the legacy of Sciamachy as well. Not only the spectral range has been extended, the spatial resolution is 3.5 by 7 km in nadir, and up to 9 by 14 km at the edges of the swath. This has been achieved while increasing the signal to noise ration compared to OMI. Of course the combination of extended spectral coverage and smaller pixel size means that the data volume is *much* larger than that of OMI.

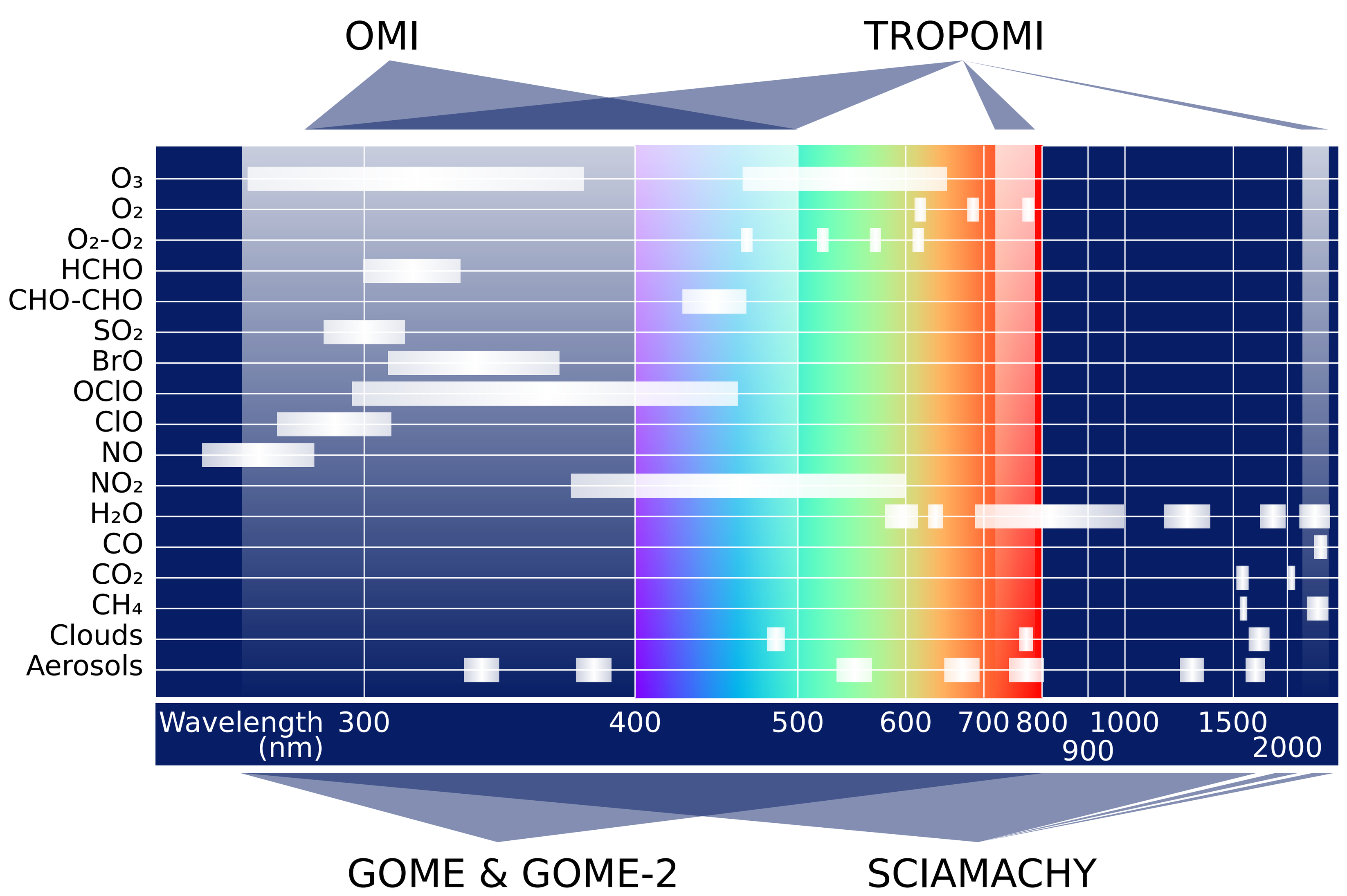
The extended wavelength range allows us to retrieve additional Level 2 products: methane and carbonmonoxide from the SWIR, and aerosol layer height from the NIR are new products compared to OMI. Having the oxygen A-band available also means that we can use it for cloud retrieval instead of the O_2-O_2 or rotational Raman scattering cloud products used on OMI.

Here we present the cloud support product that will be used by the KNMI level 2 products derived from TROPOMI observations, including nitrogen dioxide. This cloud product is an adaptation of FRESCO version 7 for TROPOMI.

The TROPOMI instrument on Sentinel 5 precursor



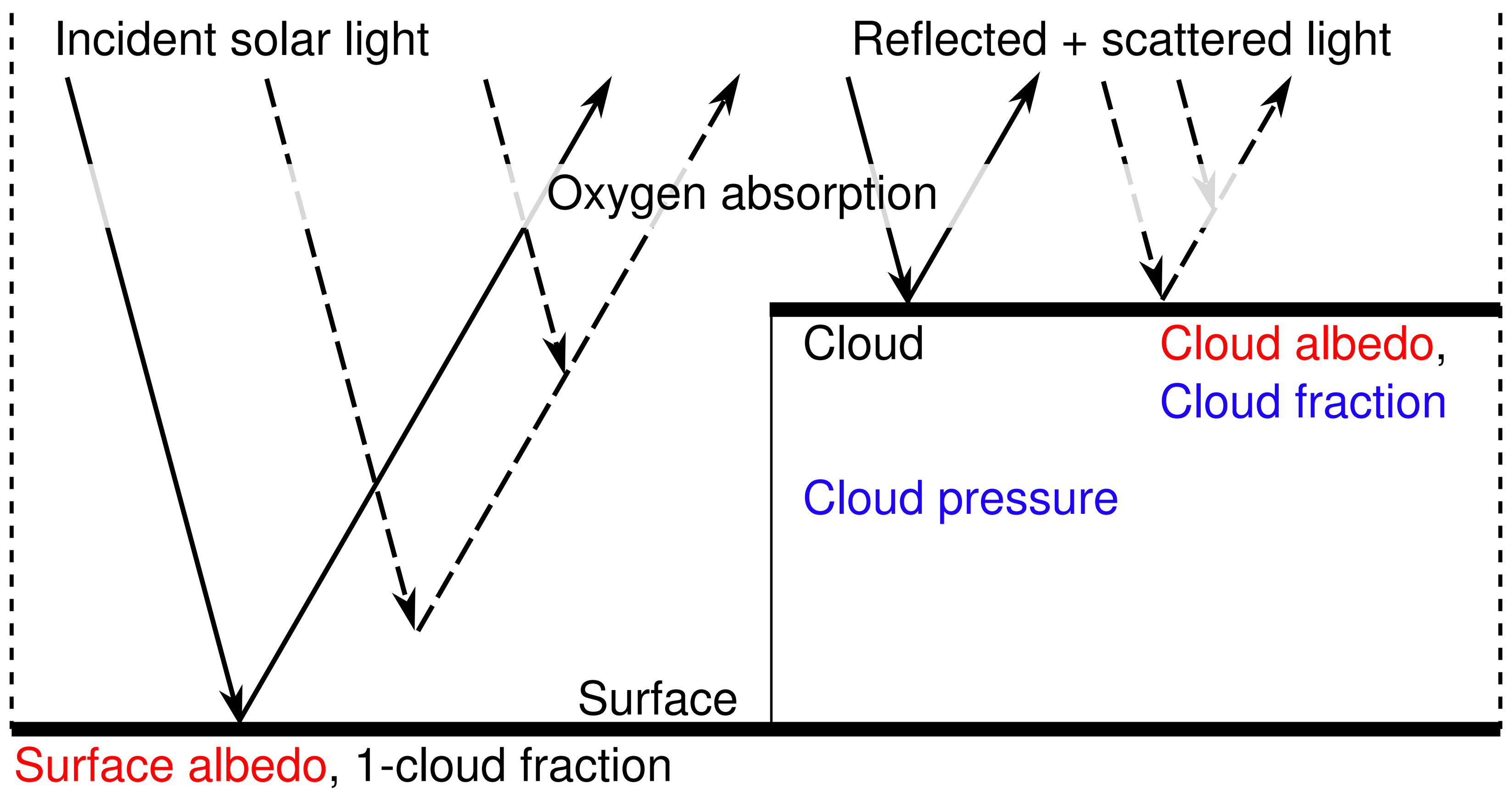
Pixel size comparison for GOME (white), Sciamachy (green), GOME-2 (red), OMI (blue) and TROPOMI (purple).



FRESCO retrieval method

The amount of oxygen absorption detected by the satellite is a direct and independent measure for cloud height. It appears from simulations and validations that due to multiple scattering, the detected level using the O2 A-band is typically the *optical mid-level* of a cloud or multilayer cloud system. This is different from the cloud top derived from thermal observations. For the cloud-correction of trace gases it is desireable to have a cloud retrieval scheme that samples the same airmass as the trace gas retrieval. For trace gas observations from UV-VIS-NIR instruments FRESCO has this property.

In our O_2 A-band retrieval algorithm, called FRESCO (Fast retrieval scheme for clouds from the oxygen A band), a pixel is assumed to consist of a clear and a cloudy part. The cloud is assumed to be a Lambertian reflector with albedo 0.8. The two retrieved quantities are the *effective cloud fraction* and *cloud pressure*, which is the apparent pressure level derived from the depth of the O_2 A-band. This cloud model is identical to the cloud model used in the OMI O_2-O_2 cloud product (or vice versa, as FRESCO is the older cloud product). A statistical analysis of the FRESCO cloud parameters and the O_2-O_2 cloud retrieval used on OMI show that both have very similar properties.



The FRESCO retrieval algorigthm has previously been applied to GOME on ERS-2 (1996-2003), Sciamachy on Envisat (2002-2012) and GOME-2 on Metop-A & B (2007-present). The daily FRESCO data are provided on TEMIS: *http://www.temis.nl/fresco*

These cloud parameters derived from O2 absorption are unique for their long time series. This series will now be extended by TROPOMI, the single payload on Sentinel 5 precursor.

Adaptations to FRESCO for TROPOMI

The FRESCO algorithm has been adapted for use on Sentinel 5 precursor data. This means that a new lookup table has been created using the TROPOMI instrument response function (ISRF). In some aspects the TROPOMI instrument is similar to OMI. TROPOMI also uses a CCD to separate wavelengths along one axis and the across track dimension along the other. As a consequence TROPOMI does not have a single ISRF, but a separate one for each viewing direction (row-index). For the NIR band there are 448 different viewing directions. Each of these viewing directions has a very limited range of viewing zenith angles it will encounter. So for each of the lookup tables the viewing angle range has been limited to the range needed for that row index (with some safety margin).

Because of the data volume produced by TROPOMI the FRESCO code has been cleaned up to allow use in a multi-threaded environment. This is needed to meet performance requirements.